

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

PPH 0125 – MECHANICS

(All sections / Groups)

27 OCTOBER 2017

3.00 p.m - 5.00 p.m

(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 pages excluding the cover page and the appendices with **FIVE** questions only.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

Answer ALL questions.

Question 1: [10 marks]

- a) With moment of inertia of 0.25 kg.m^2 , a bicycle wheel is known to slow down from 300 rpm to 100 rpm in 1.5 minute due to its pivot's internal frictional torque. Calculate the external torque required to accelerate it from zero to 500 rpm in 60.0 s. (6 marks)
- b) An old disc record player has a disc-shaped turntable of radius 330.0 cm and mass 1000.0 g. The moment of inertia of this turntable is $0.5mr^2$ where m and r are the mass (in kilogram) and radius (in meter) respectively. The turntable is given a push to rotate at a constant angular speed of 45 rpm (assume negligible friction). Then, an old vinyl record disc of moment of inertia $4.5 \times 10^{-3} \text{ kg.m}^2$ is dropped onto the rotating turntable and subsequently driven to the same angular speed as the turntable. What is the new angular speed of the combined bodies of turntable and vinyl record disc? (4 marks)

Question 2: [10 marks]

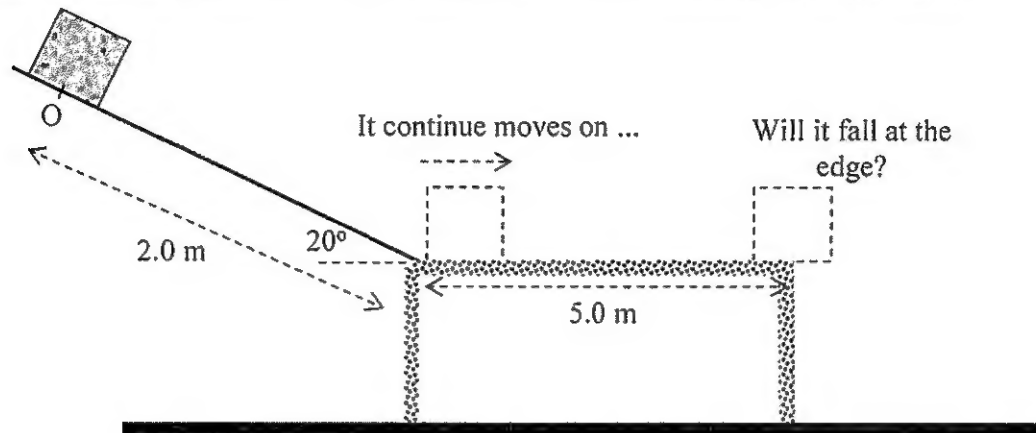
An object of mass, $M = 2.0 \text{ kg}$, is attached to a spring of spring constant $k = 50 \text{ N/m}$ which is compressed a distance $d = 20 \text{ cm}$ and then released from rest. Assume that the mass is moving on a horizontal, frictionless surface.

- a) Find the speed of the object when it has gone past the equilibrium point and is being *stretched* further a distance of 10 cm. (2 marks)
- b) Write an equation for the position of the object as a function of time, with $t = 0$ being the instant that the mass was first released from rest. Use this equation to find out how long it takes the mass to get from the initial point (release point) to the point where the spring is stretched by 10 cm. (5 marks)
- c) Write an equation for the velocity as a function of time, using the same definition of $t = 0$ as in part (b). Use this equation to find the velocity (magnitude and direction) when the time is $t = 3T/4$ where T is the period of motion of the mass on the spring. (3 marks)

Continued...

Question 3: [10 marks]

A 30.0-kg block is released from rest at a point (O) on top of a smooth incline as shown in Figure Q3. It gains its velocity when sliding down for 2.0 m, reaching at the bottom of the incline and continue to move on the horizontal platform of coefficient of friction 0.15. If the horizontal platform is 5.0 m in length, will it fall at the edge of the platform?

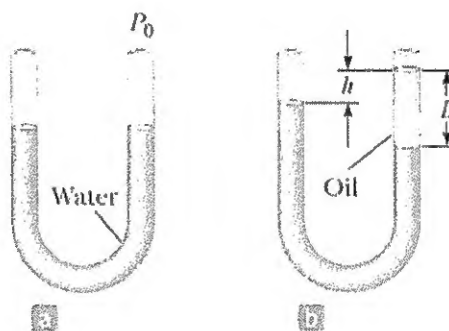
**Figure Q3****(10 marks)****Question 4: [10 marks]**

- a) A small object of mass m is launched from the surface of the Earth with a speed of v_0 in a direction perpendicular to the Earth's surface.
- Find an expression for the speed v of the object at a height $h = R_e$, in terms of v_0 , the radius of the Earth R_e , the mass of the Earth M_e , and the gravitational constant G .
(2 marks)
 - Calculate the minimum value of v_0 that will allow the object to reach the height h .
(2 marks)
 - Now consider a different situation where the object is placed in a circular orbit at a height $h = R_e$. Find the velocity the object needs, in order to be in a circular orbit at that height.
(2 marks)
- b) A coordinate system (in meters) is constructed on a table, and three objects are placed on the table as follows: a 2.0-kg object at the origin of the coordinate system, a 3.0-kg object at (0, 2.0), and a 4.0-kg object at (4.0, 0). Find the resultant gravitational force exerted by the other two objects on the object at the origin.
(4 marks)

Continued...

Question 5: [10 marks]

- a) A rectangular wooden block of weight W floats in water with exactly one-half of its volume below the waterline. When a 20.0 g mass is placed on top of the wooden block, the top of the wooden block is leveled with the waterline. Given that density of water is 1.00 g/cm^3 ,
- what is the mass of the wooden block?
(3.5 marks)
 - The wooden block is removed from the water bath and placed in an unknown liquid. In this unknown liquid, only one-third of the wooden block is submerged. What is the density of the unknown liquid?
(2.5 marks)
- b) A U-tube open at both ends is partially filled with water. Oil is then poured into the right arm and forms a column $L = 5.00 \text{ cm}$ high as shown in Figure Q5. Determine the difference h in the heights of the two liquid surfaces. Density of water = 1000 kg/m^3 and density of oil = 750 kg/m^3 .
(4 marks)

**Figure Q5****End of Paper**

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Proton mass,	m_p	$1.67 \times 10^{-27} \text{ kg}$
Elementary charge	e	$1.602 \times 10^{-19} \text{ C}$
Gravitational constant	G	$6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_0	-13.6 eV
Boltzmann's constant	k_B	$1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength	λ_c	$2.426 \times 10^{-12} \text{ m}$
Planck's constant	h	$6.626 \times 10^{-34} \text{ J.s}$
Speed of light in vacuum	c	$3.0 \times 10^8 \text{ m/s}$
Rydberg constant	R_H	$1.097 \times 10^7 \text{ m}^{-1}$
Acceleration due to gravity,	g	9.81 m/s^2
Atomic mass unit (1u)	u	$1.66 \times 10^{-27} \text{ kg}$
Avogadro's number	N_A	$6.023 \times 10^{23} \text{ mol}^{-1}$
Threshold of intensity of hearing	I_0	$1.0 \times 10^{-12} \text{ W/m}^2$
Coulomb constant	k	$8.988 \times 10^9 \text{ N.m}^2/\text{C}^2$
Permittivity of free space	ϵ_0/κ_0	$8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$
Permeability of free space	μ_0	$4\pi \times 10^{-7} \text{ H/m}$

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	9.81 m/s^2
Radius	=	$6.38 \times 10^6 \text{ m}$
Mass	=	$5.98 \times 10^{24} \text{ kg}$

Moon:

Mass	=	$7.35 \times 10^{22} \text{ kg}$
Radius	=	$1.74 \times 10^6 \text{ m}$

Sun:

Mass	=	$1.99 \times 10^{30} \text{ kg}$
Radius	=	$6.96 \times 10^8 \text{ m}$

Mean distance from:

Sun to Earth	=	$1.50 \times 10^{11} \text{ m}$
Moon to Earth	=	$3.85 \times 10^8 \text{ m}$

APPENDIX II

List of Formulas

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$
$v = v_o + gt$	$y - y_o = v_o t + \frac{1}{2} gt^2$	$v^2 = v_o^2 + 2g(y - y_o)$	$y - y_o = \left(\frac{v_o + v}{2} \right) t$
$a_o = \frac{v^2}{r}$	$F_g = G \frac{m_1 m_2}{r^2}$	$U_g = -G \frac{m_1 m_2}{r}$	$T^2 = K_s r^3$
$\tau = r \times F$	$\sum \tau = \tau_{net} = I\alpha$	$I = \sum mr^2$	$v = r\omega$
$L = r \times p = I\omega$	$K = \frac{1}{2} I\omega^2$	$ \tau = r F \sin\theta$	
$T_s = 2\pi\sqrt{\frac{m}{k}}$	$T_p = 2\pi\sqrt{\frac{I}{g}}$	$T = \frac{2\pi}{\omega} = \frac{1}{f}$	$\bar{y} = \frac{\sum_{i=1}^N m_i y_i}{\sum_{i=1}^N m_i}$
$x = A \cos \omega t$	$x = A \sin \omega t$	$W_F = r F \cos\theta$	
$v = -\omega A \sin \omega t$	$v = \omega A \cos \omega t$		
$a = -\omega^2 A \cos \omega t$	$a = -\omega^2 A \sin \omega t$		
$v = \frac{\Delta x}{\Delta t}$	$a = \frac{\Delta v}{\Delta t}$		
$v = v_o + at$	$x - x_o = v_o t + \frac{1}{2} at^2$	$v^2 = v_o^2 + 2a(x - x_o)$	$x - x_o = \left(\frac{v_o + v}{2} \right) t$
$W = mg$	$\sum F = F_{net} = ma$	$f_s \leq \mu_s F_N$	$f_k = \mu_k F_N$
$p = mv$	$\sum F = \frac{\Delta p}{\Delta t}$	$\sum W = \frac{1}{2} mv^2 - \frac{1}{2} mu^2$	
$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$	$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$	$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$	
$K = \frac{1}{2} mv^2$	$PE_s = \frac{1}{2} kx^2$	$F_s = -kx$	$PE_G = mgy$
$\bar{x} = \frac{\sum_{i=1}^N m_i x_i}{\sum_{i=1}^N m_i}$	$W_{Fs} = \frac{1}{2} kx_i^2 - \frac{1}{2} kx_f^2$		